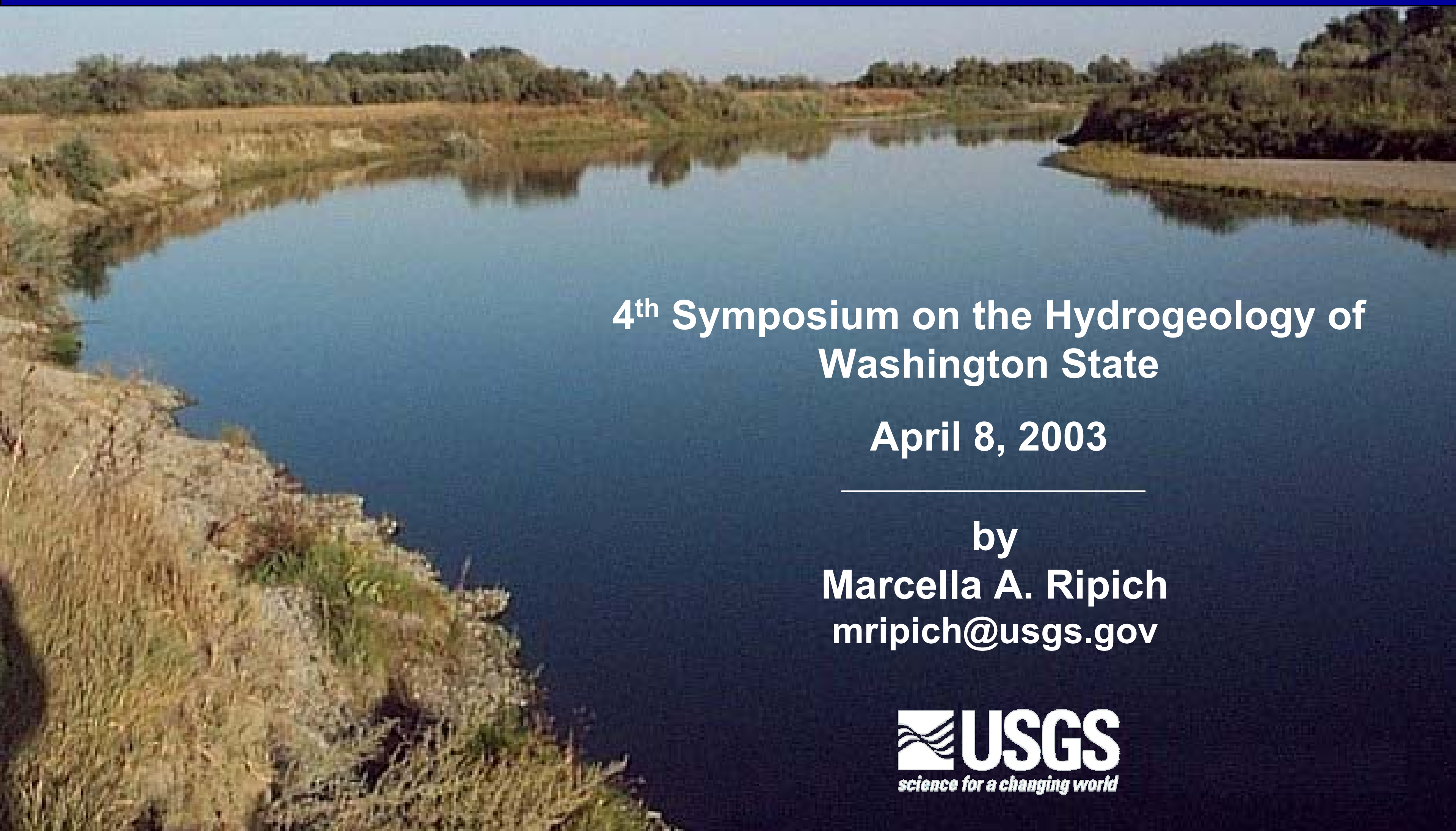
Methods to Estimate Unmetered Ground-Water Withdrawals in the Yakima River Basin, Washington



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by
Marcella A. Ripich
mripich@usgs.gov

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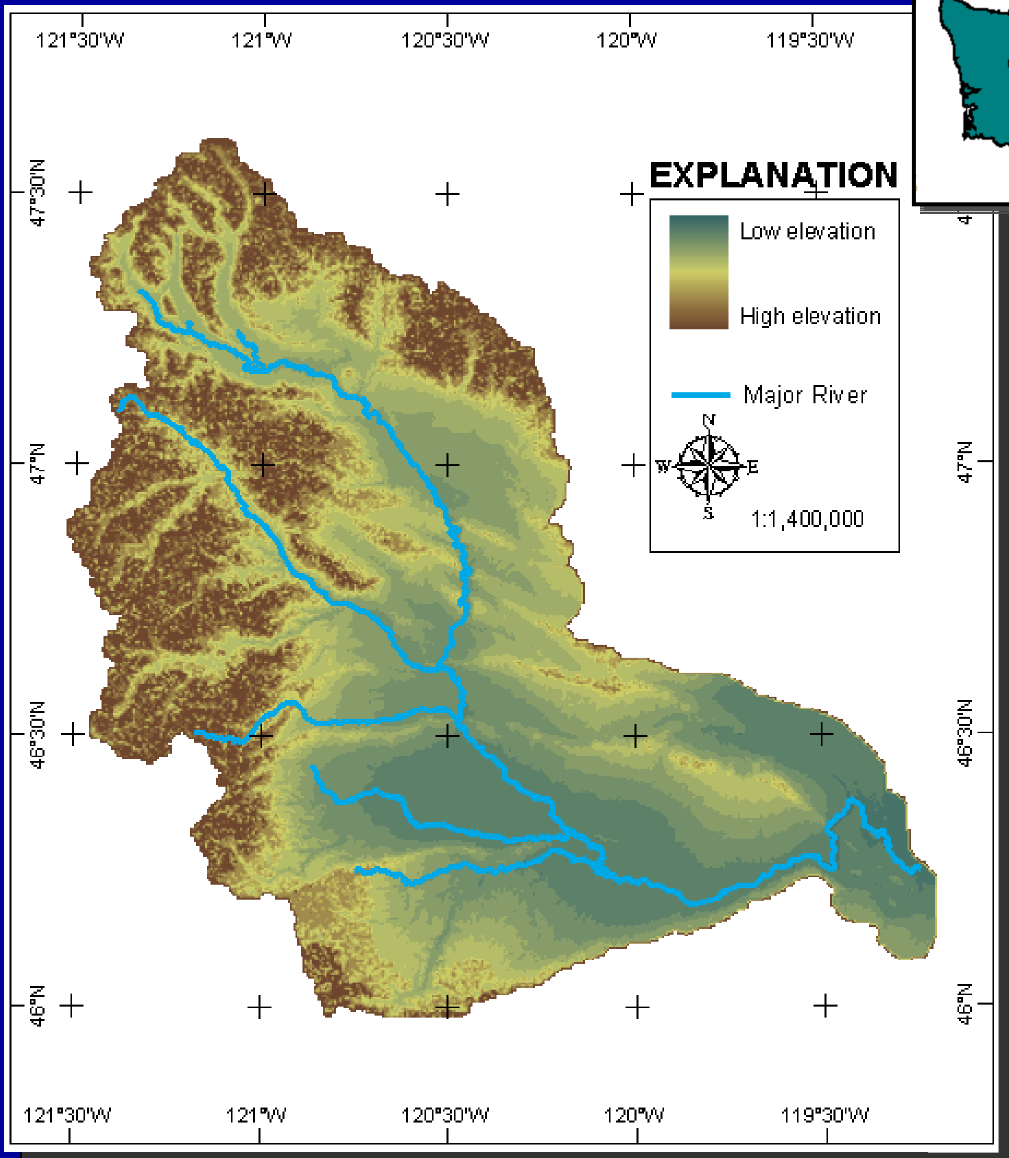
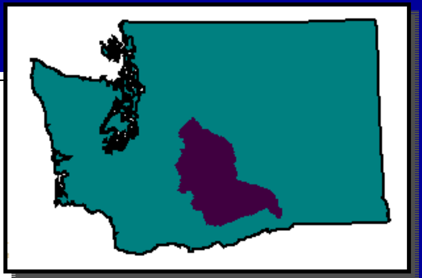
Yakima River Basin, Washington





- Demands for ground water are increasing
- Total volume of pumped ground water is unknown
- Methods to estimate unmetered pumpage are needed

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Approach

- Census data

- Metered pumpage

- Water rights

- Land use / water application rates

- Energy consumption

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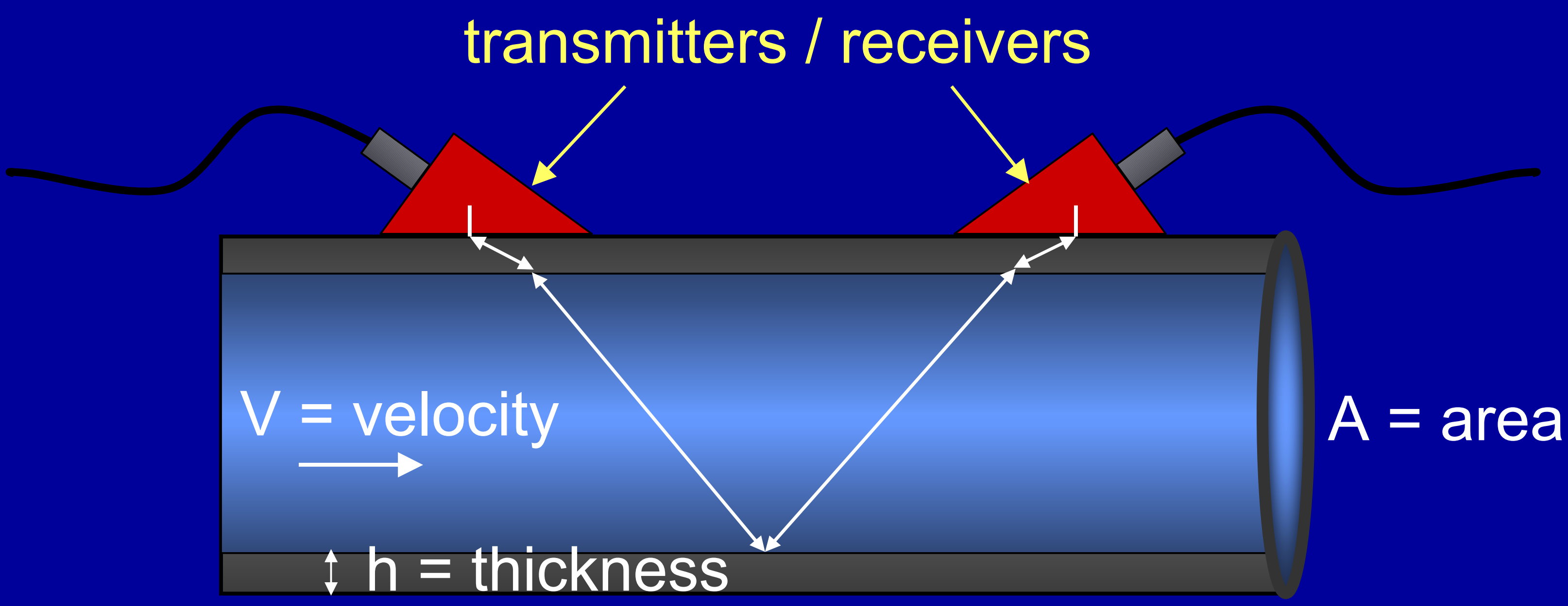
Outline

1. **Flow-rate measurements at irrigation wells using ultrasonic signals**
2. **Electrical power demand**
3. **Power consumption coefficient (PCC)**

1. Flow Measurements: Ultrasonic Signals



Q = V x A

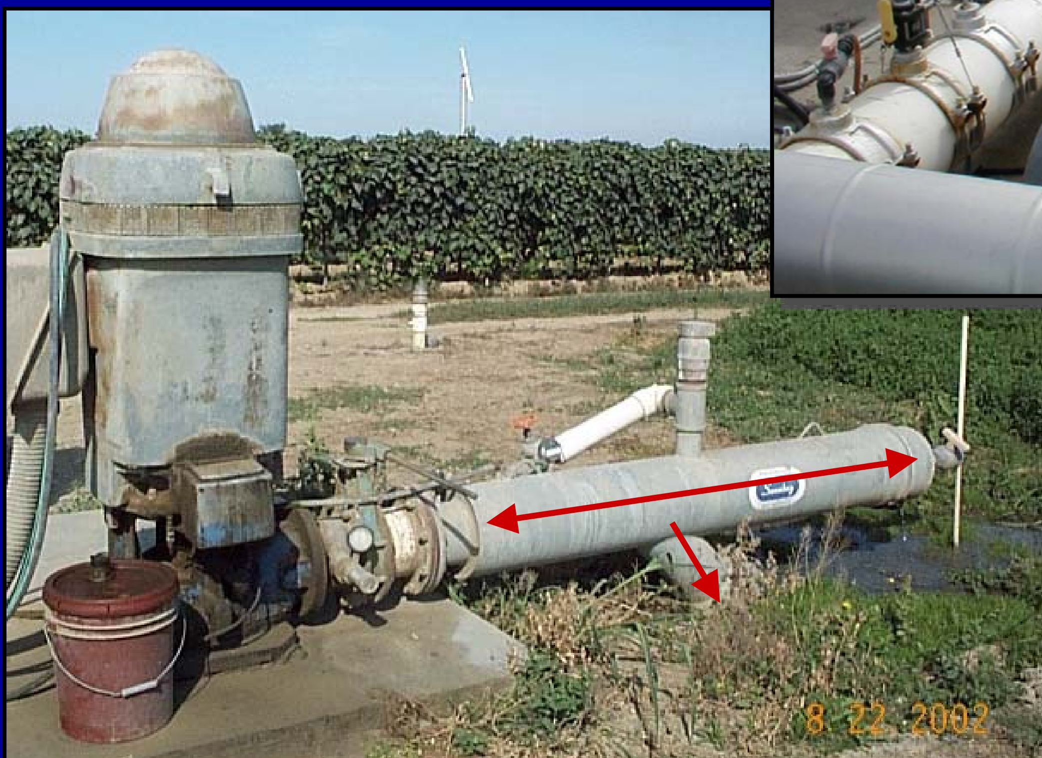
Ultrasonic Flow Meter

- A (cross-sectional area) is known
- V (fluid velocity) is computed from Δt

1. Flow Measurements: Ultrasonic Signals (cont’d)

- Full pipe flow
- Minimum turbulence - 10 pipe diameters of straight pipe downstream of elbows or valves
- Clean surface for transducers

Obstacles



Straight pipe is ~10 pipe diameters

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2. Electrical Power Demand

Measured at watthour-meter

P = diskrate x Kh factor x 3.6

Where P is power demand in kW
diskrate in rev / sec
Kh factor in Wh / rev
3.6 is conversion factor

Current Transformer Ratios

P = diskrate x Kh factor x 3.6 x 80

3. Power Consumption Coefficient (PCC)

Rating factor for the pumping installation

$$PCC = P / Q \times 5{,}433$$

Where

- PCC in kWh / acre-ft
- P power demand in kW
- Q flow rate in gpm
- 5,433 is conversion factor

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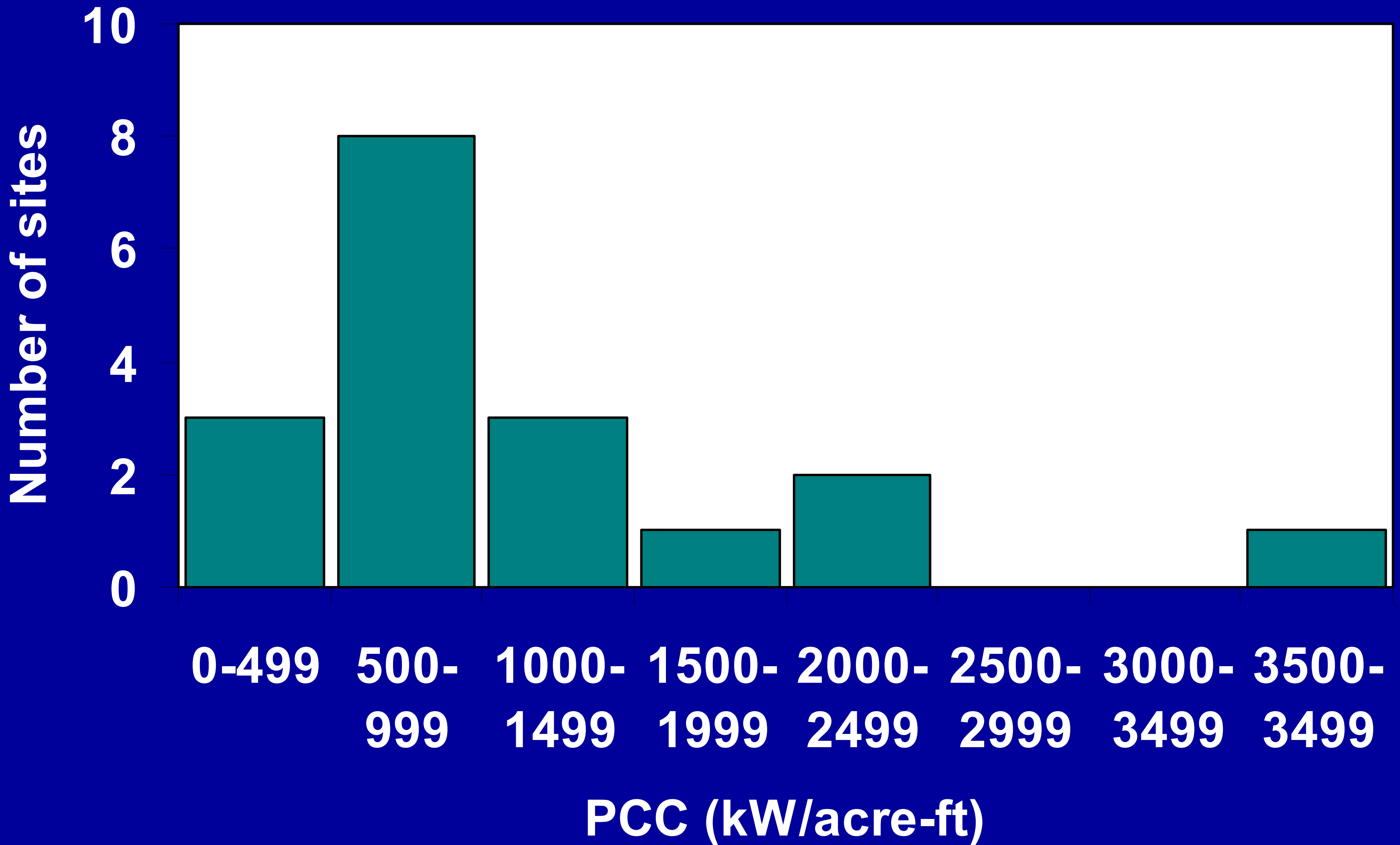
3. Power Consumption Coefficient (PCC) (cont'd)



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PCC can vary at a location due to

- changing pumping installations
- changing hydrologic conditions

Future steps:

- Measure PCC's during different times of the year.
- Correlate PCC's with hydrologic conditions and installation type.
- Apply appropriate PCC's to known electrical usage over time to calculate the volume pumped.

Summary

Several methods to estimate pumpage, including electrical energy consumption

- PCC relates power demand to pumping rate
- PCC's measured and related to pump-site characterisitics
- Appropriate PCC's applied to electrical usage to estimate volume pumped

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More Information

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